IPP COMMON SENSING
CommonSensing
Platform Solutions
Building climate resilience with small island nations
LEBA GAUNAVINAKA
UNOSAT Programme, UNITAR

Outline

- CommonSensing Project
  - Objectives, Deliverables, Implementing Partners
- Progress Update
  - Services provided
  - Platform solutions
  - End- User testing
- Concluding remarks

Background:

- CommonSensing is a three year project that the Fijian Government has embarked on based on a partnership with the UK Space Agency's International Partnership Program (IPP)

- CommonSensing Project is aimed at leveraging satellite technology and satellite derived products to support Commonwealth SID nations in the Pacific - Fiji, Vanuatu and Solomon Islands in four thematic areas

Enhanced Resilience to Climate Change

Enhancing Food Security

Disaster Risk Reduction from Natural Hazards

Improving access to Climate Finance

Implementing Partners:

- CommonSensing is implemented by a Consortium of International partners lead by the United Nations Institute for Training and Research (UNITAR)

UNOSAT

United Nations Operational Satellite Applications Programme (UNOSAT)

unitar
United Nations Institute for Training and Research

United Nations Institute for Training and Research (UNITAR)

Met Office

UK Meteorological Office

The Commonwealth

Commonwealth Secretariat

sensonomic

Sensomic

UNIVERSITY OF PORTSMOUTH

University of Portsmouth

CATAPULT
Satellite Applications

Sattelite Application Catapult

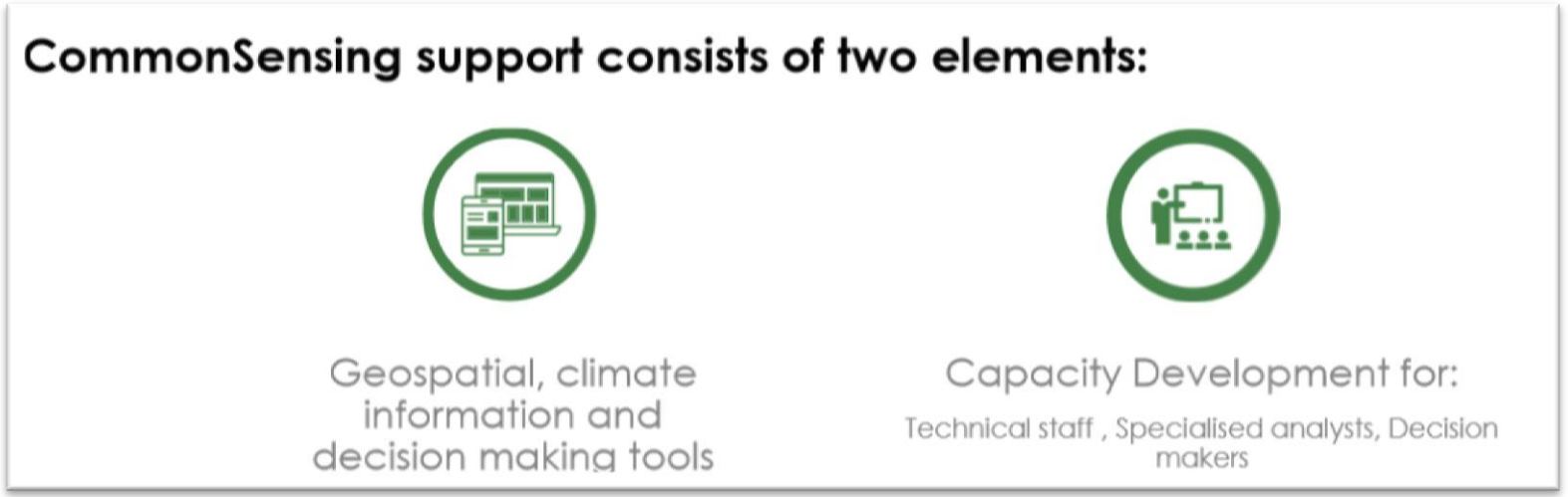
devex
Do Good. Do It Well.™

Devex

CommonSensing Service

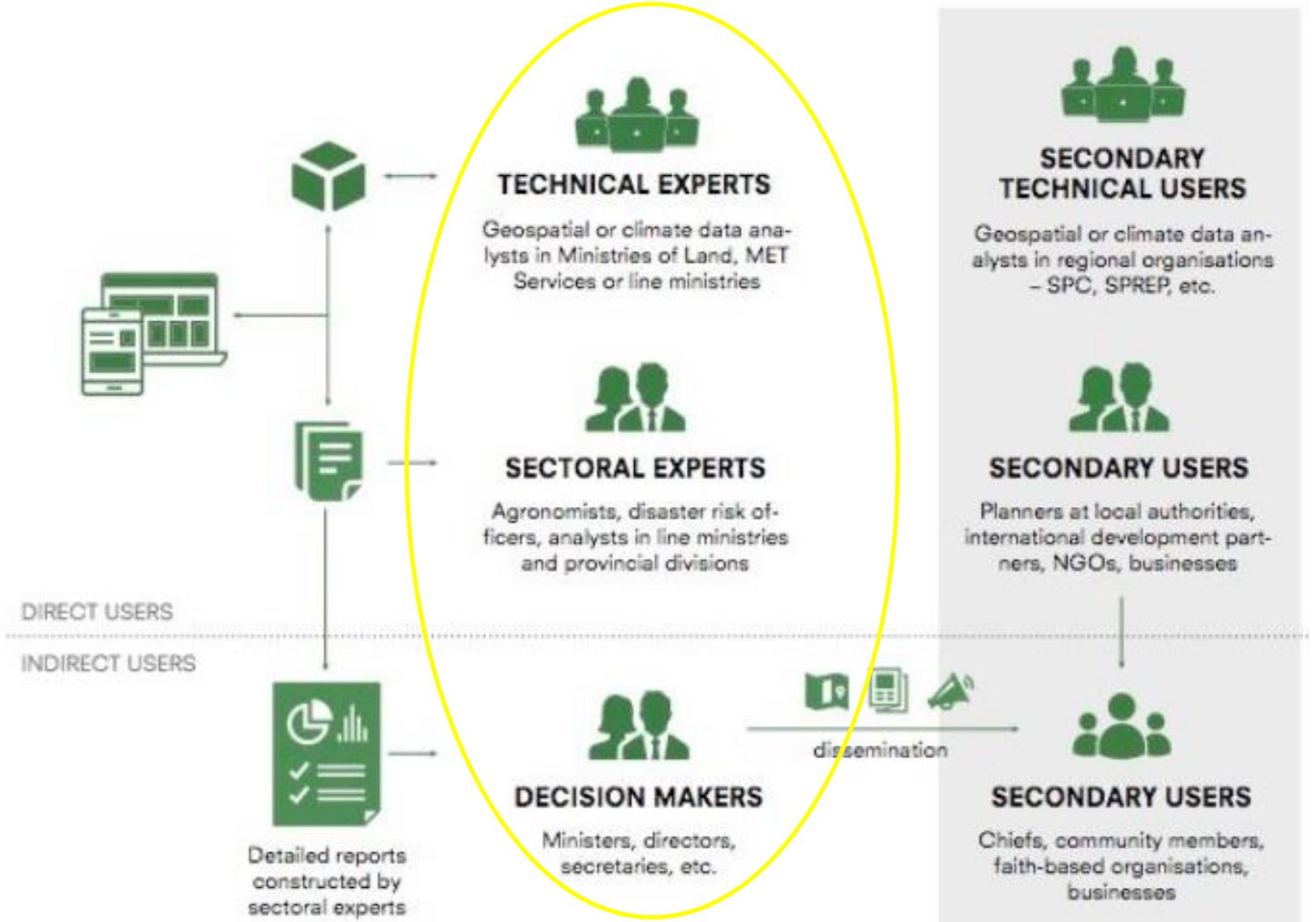
The project strengthens climate resilience by;

- **Developing geospatial and climate information and systems** that meet identified challenges and needs for each country for decision support.
- **Strengthening access to climate finance** and report on climate funds including national and regional climate action policy



End Users

CommonSensing focuses primarily on supporting the centralised stakeholders and decision makers within the national government.



Stakeholders

1. Climate Change & International Cooperatio
   Division, Ministry of Economy
2. Ministry of Lands & Mineral Resources
3. National Disaster Management Office
4. Fiji Meteorological Services
5. Ministry of Agriculture
6. Ministry of Sugar Industry
7. Ministry of Waterways & Environment

With Government ITC Data Centre as core enabler

* Note: Secondees from MLMR, MoA, NDMO

However, the landscape is vast and many more stakeholders are acknowledged as potential beneficiaries and collaborators to the CS service, including other governmental organizations, regional organizations and end-user communities.

Timeframe: Phase 1 and Phase 2

COMMONSENSING

Inception Trip 2018

Validation Trip Feb 2019

Engagement trip June 2019

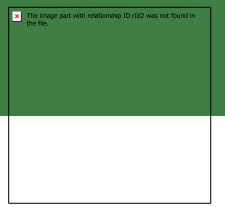
Political launch in Fiji, SI/Van engagement trip

MVP Available in country March 2020

End User Testing/ solution iterations

Project Completion March 2021

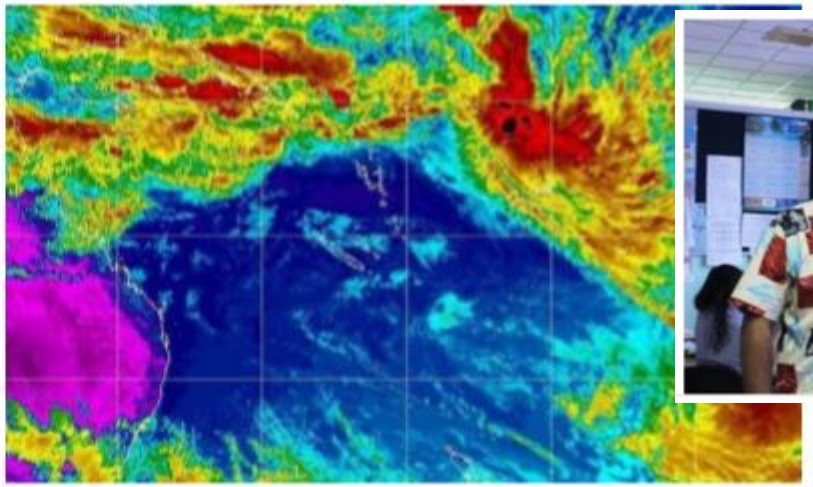
13 November 2019 Press Conference



Thematic Technical Trainings

Thematic Technical Training

Climate Learning for Adaptation and Resilience' (CLEAR) Workshop, 7-11 October 2019 at Nadi, Fiji



- ✓ Regional workshop conducted by **UK Met Office** that brought together experts from Solomon Island, Vanuatu, and Fiji Meteorological services;

- ✓ Targeted Met experts using or aiming to use long-term climate projections in their work;

March 10-12, 2020, Port Villa.

Thematic Technical Training

CommonSensing Workshop - 4-8 November, 2019 at USP

Data Gathering from the Web, download and use data for DRR and Climate Applications

- USGS Earth Explorer
- EO Browser
- Copernicus Sentinels Scientific Data Hub
- Giovanni
- Digital Globe / Maxar
- The Humanitarian Data Exchange
- ArcGIS Online
- OSM and BBBike
- World Pop
- Maps and Data from UNSOAT archives

Basic Remote Sensing Operations with ArcMap

- Band Combinations
- NDVI calculations
- Image Enhancements

ArcGIS 1 year license for

Advanced EO & GIT Training

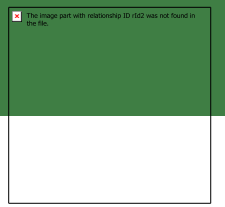
Modules

1. Change detection with GEE
    1. Water bodies
    2. Land use land cover
    3. NDVI

2. Digital Image Classification
3. Supervised & Unsupervised classification (LULC)

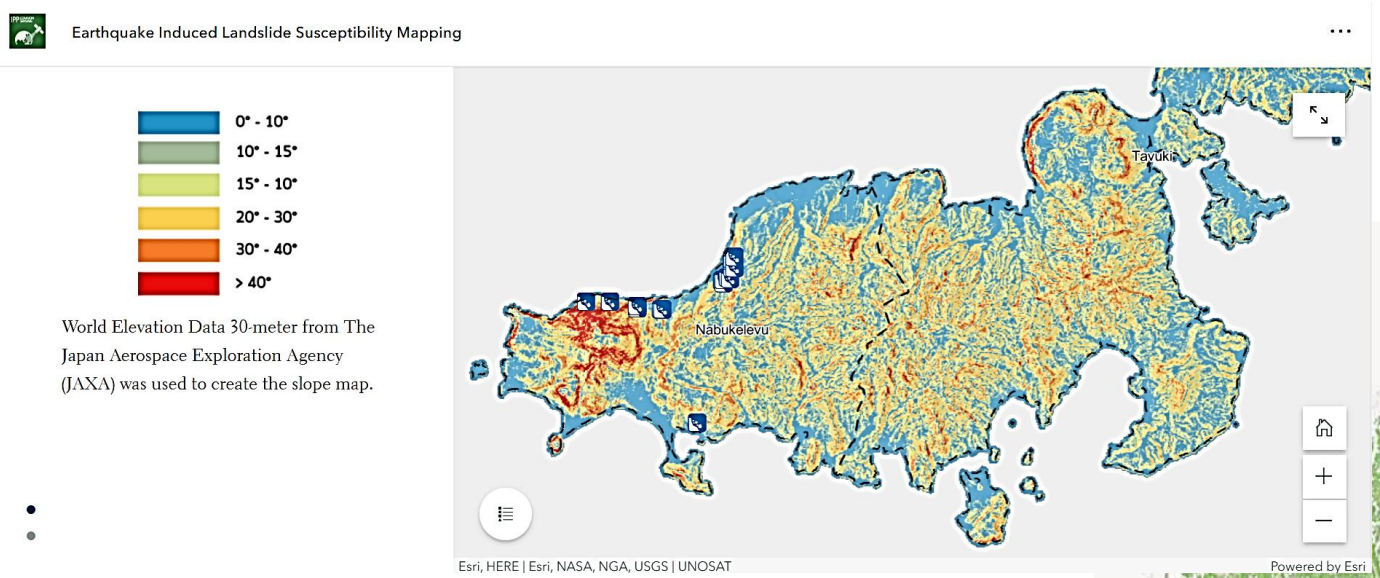
3. Rapid mapping response
    1. Population exposure analysis
    2. Sources of data (OpenSource, Local authoritative)
    3. Infographics
4. Geodatabase management
    1. Topology, domains and subtypes
    2. Webmapping

ArcGIS 1 year license for participants



Technical support (backstopping services)

Earthquake induced landslide susceptibility map (shared with NDMO & MRD)



Geologic Group		Slope Angle, degrees					
		0-10	10-15	15-20	20-30	30-40	> 40
(a) DRY (groundwater below level of sliding)							
A	Strongly Cemented Rocks (crystalline rocks and well cemented sandstone, c' =300 psf, φ' = 35°)	None	None	I	II	IV	VI
B	Weakly Cemented Rocks and Soils (sandy soils and poorly cemented sandstone, c' =0, φ' = 35°)	None	III	IV	V	VI	VII
C	Argillaceous Rocks (shales, clayey soil, existing landslides, poorly compacted fills, c' =0 φ' = 20°)	V	VI	VII	IX	IX	IX
(b) WET (groundwater level at ground surface)							
A	Strongly Cemented Rocks (crystalline rocks and well-cemented sandstone, c' =300 psf, φ' = 35°)	None	III	VI	VII	VIII	VIII
B	Weakly Cemented Rocks and Soils (sandy soils and poorly cemented sandstone, c' =0, φ' = 35°)	V	VIII	IX	IX	IX	X
C	Argillaceous Rocks (shales, clayey soil, existing landslides, poorly compacted fills, c' =0 φ' = 20°)	VII	IX	X	X	X	X

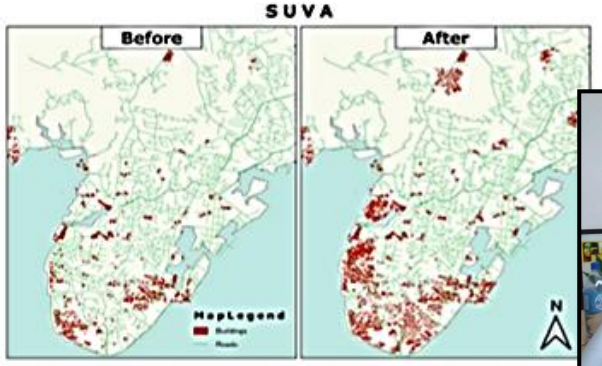
[Wilson & Keefer 1985 method]

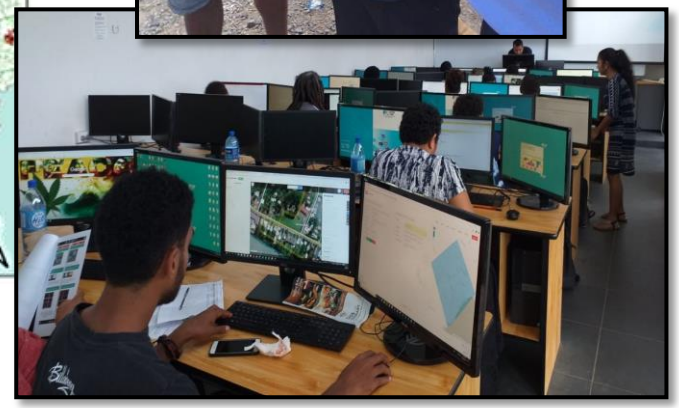
Technical Support/Capacity Development

Fiji Missing Mapathon Mapathon, 26-28 August 2019, Suva, Fiji

- ✓ Jointly organized by UNOSAT, USP and MOE

Mapathon aimed to engage government stakeholders and academia to map out unmapped infrastructure and other critical information to support disaster preparedness efforts.





- ✓ Experienced mapathon expert from OSM Asia Pacific Office in Indonesia was engaged to conduct the event;
- ✓ 51 Participants (40%F, 60%M) mapped out **3148 buildings, 83 highways, 66 land-uses and 6 waterways** and are updated and made available on the OpenStreetMap

Further updates on missing buidings within 34 identified red zones

NFA – OSM Hydrants training

unitar
United Nations Institute for Training and Research

REPUBLIC OF FIJI

Kadavu Province, Eastern Division

Imagery analysis: 12 April 2020 | Published 19 April 2020 | Version 1.0

Tropical Cyclone

TC20200406FJI

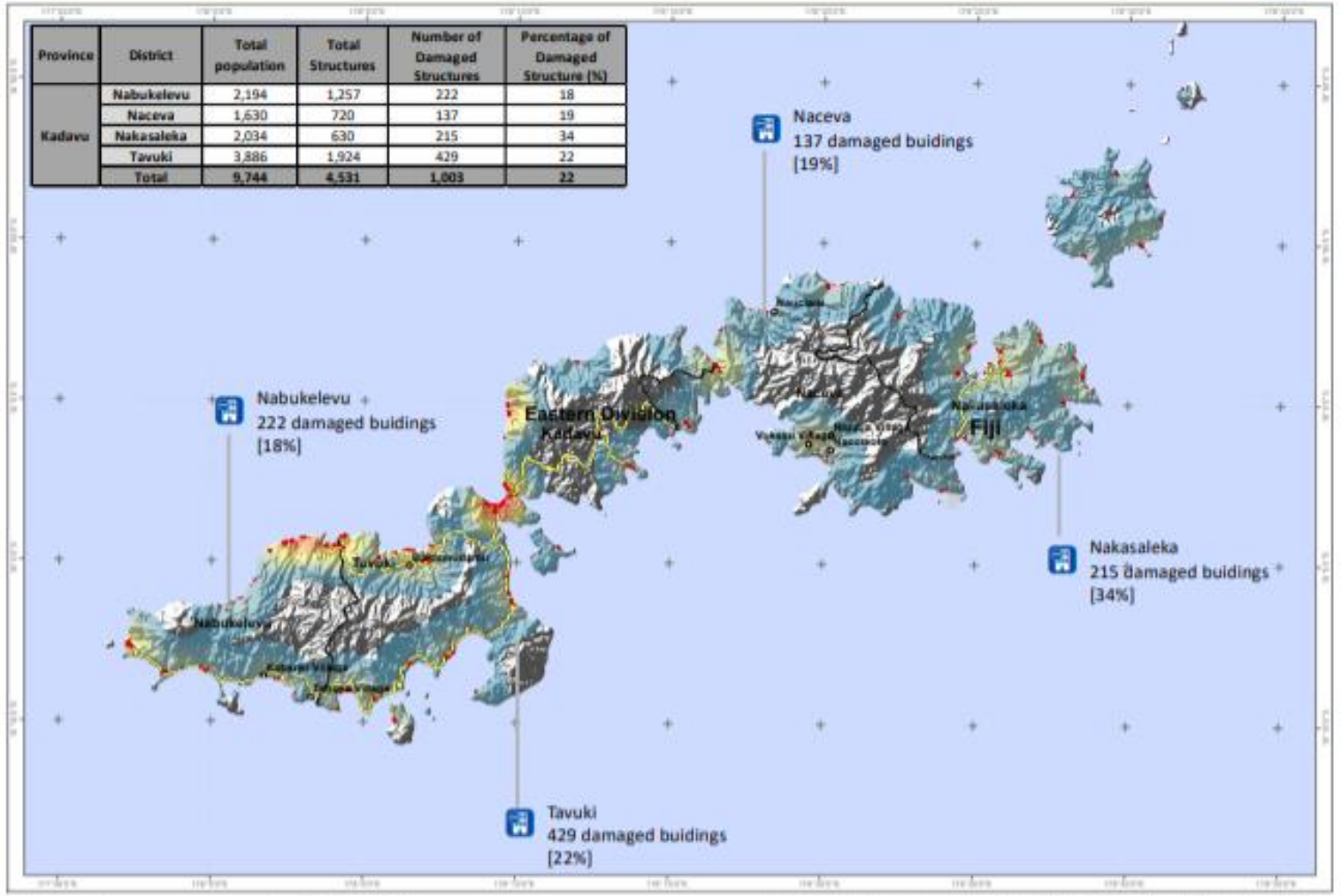
UNOSAT

Province	District	Total population	Total Structures	Number of Damaged Structures	Percentage of Damaged Structure (%)
Kadavu	Nabukelevu	2,194	1,257	222	18
	Naceva	1,630	720	137	19
	Nakasaleka	2,034	630	215	34
	Tavuki	3,886	1,924	429	22
	Total	9,744	4,531	1,003	22

Buildings Damage Assessment & Related Density in Kadavu Province, Eastern Division, Republic of Fiji

This map illustrates potentially damaged structures, buildings and their related density in Kadavu Province, Eastern Division, Republic of Fiji as detected by satellite images acquired on 12 April 2020. Within the Kadavu Province, UNITAR-UNOSAT identified in the cloud free zones 1,003 potentially damaged structures. Taking into account the pre-building footprints provided by OpenStreetMap, this represents about 22% of the total number of structures within the analyzed cloud free areas.

This is a preliminary analysis and has not yet been validated in the field. Please send ground feedback to UNITAR - UNOSAT.



Legend
- Town/Village
- Damaged Structure
- Road
- District boundary

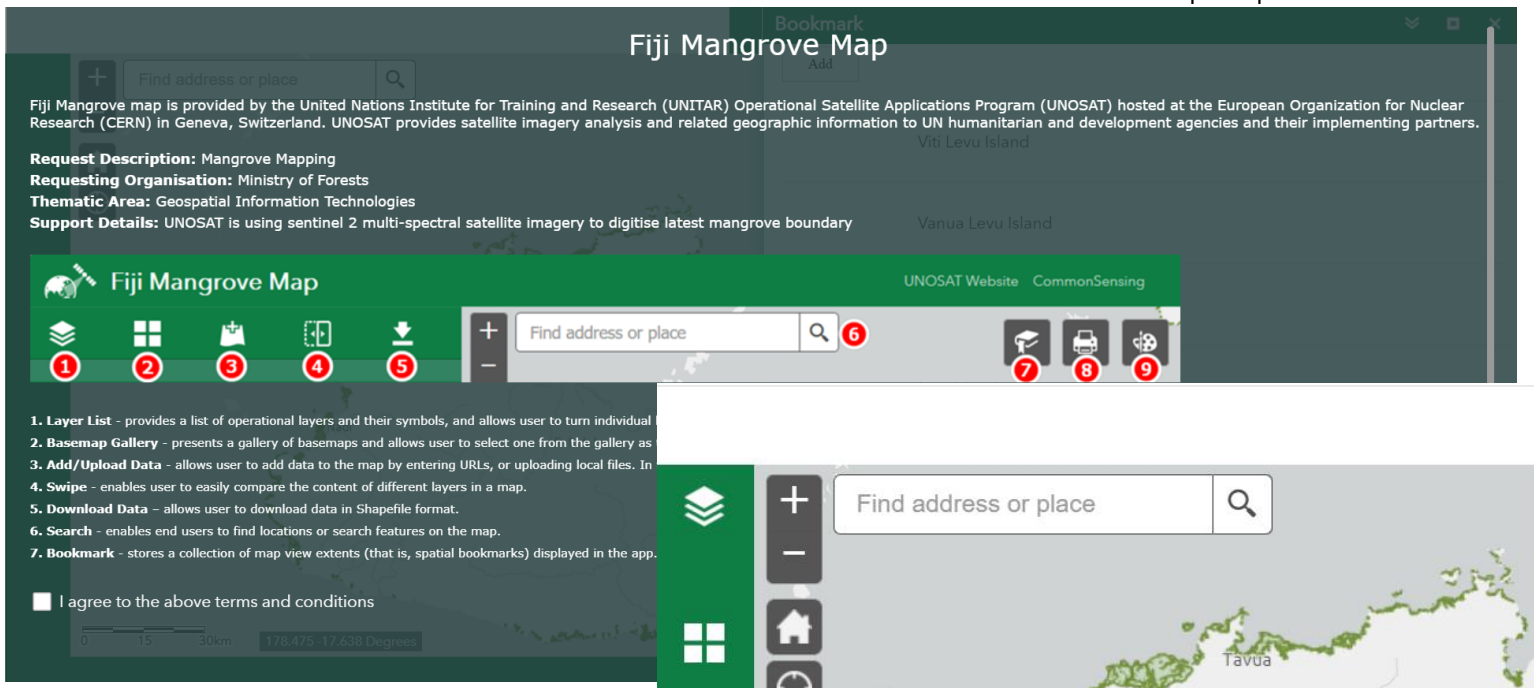
Damage Density
High
Low

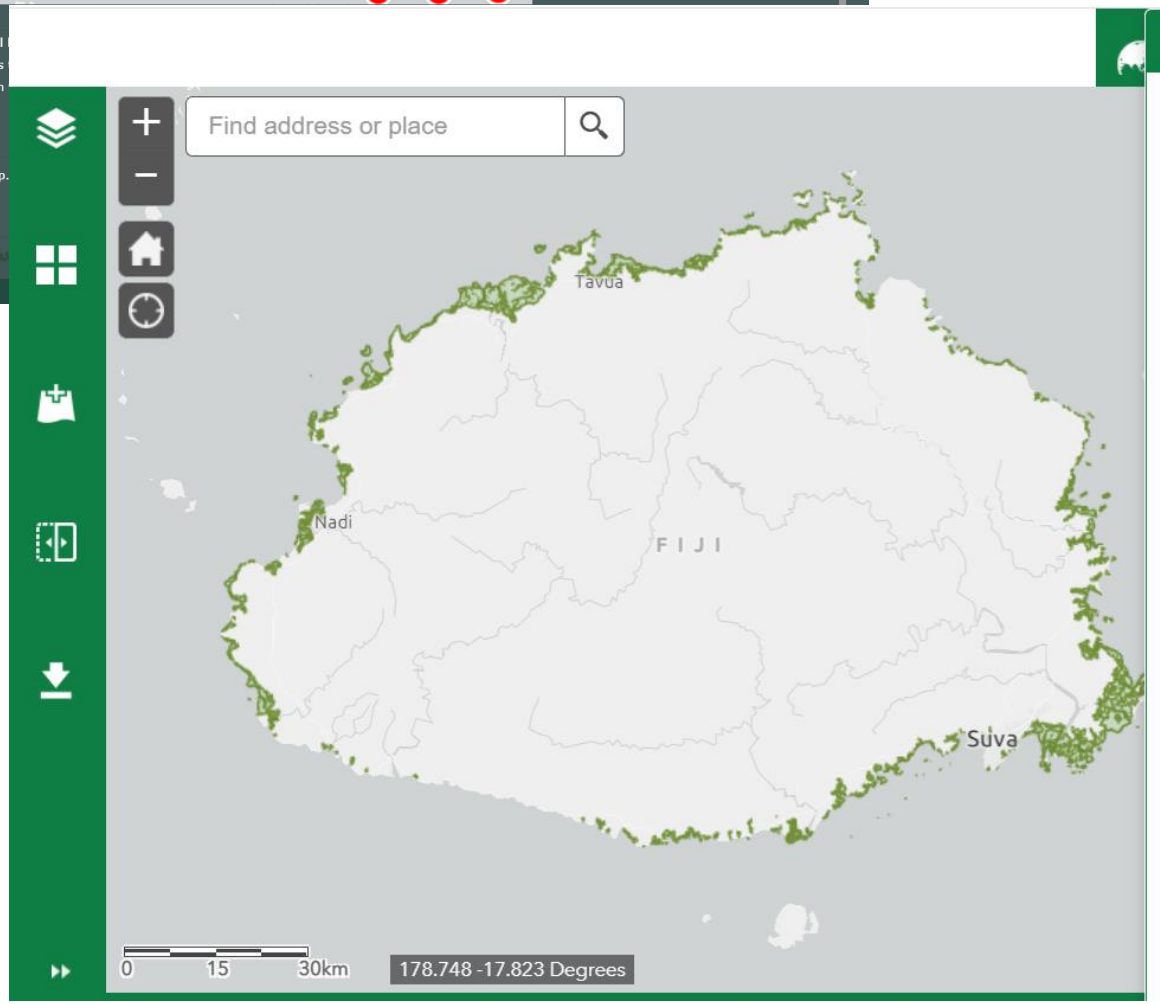
cnes

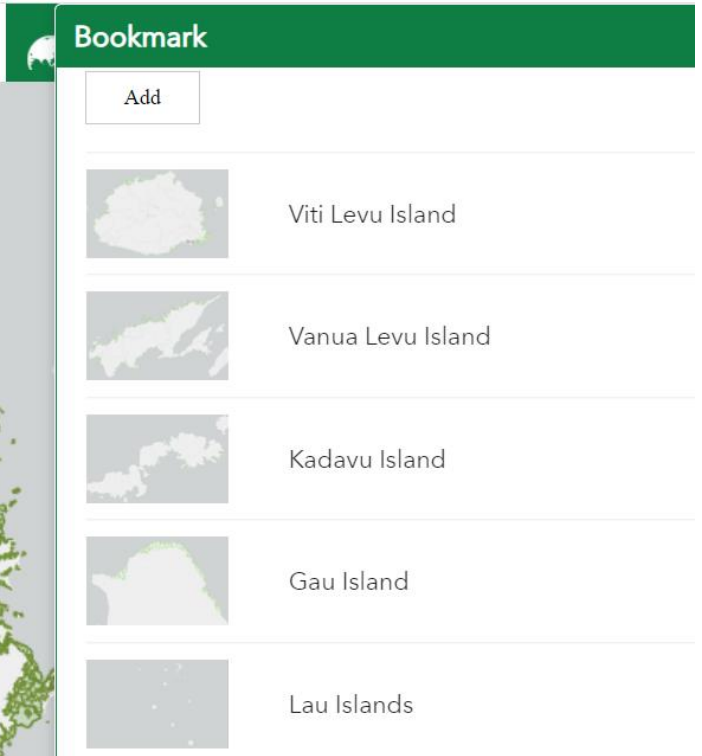
Map Scale for A3: 1:225,000

UNITAR - UNOSAT - Palais des Nations CH-1211 Geneva 10, Switzerland - T: +41 22 767 4020 (UNOSAT Operations) - Hotline 24/7: +41 75 411 4995 - unosat@unitar.org - www.unitar.org/unosat

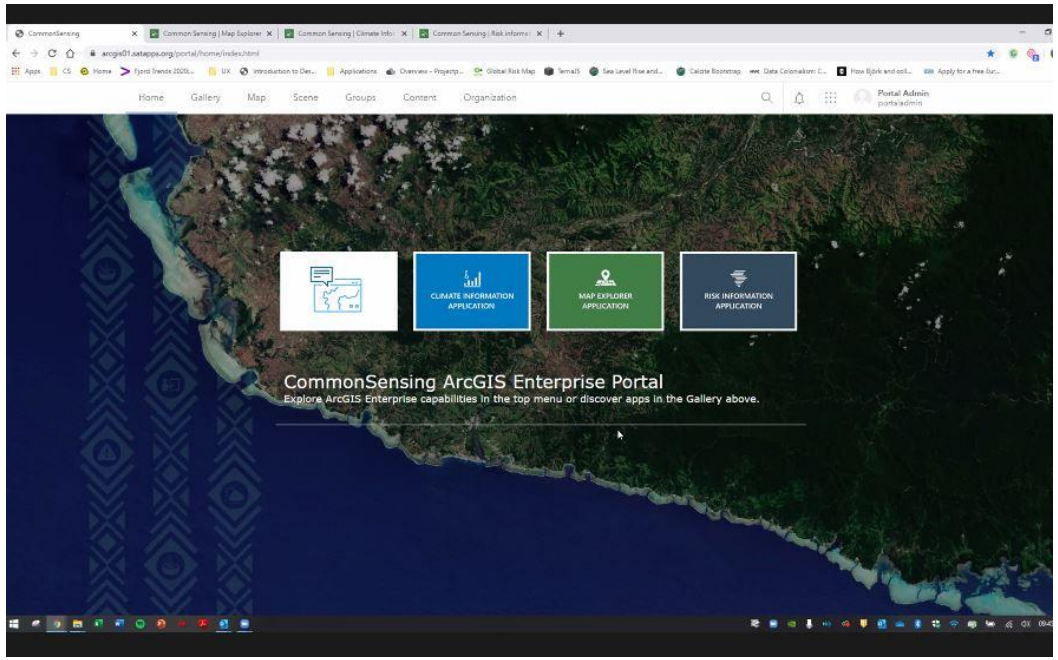
UNOSAT can activate the space charter during emergencies to support rapid response mapping.

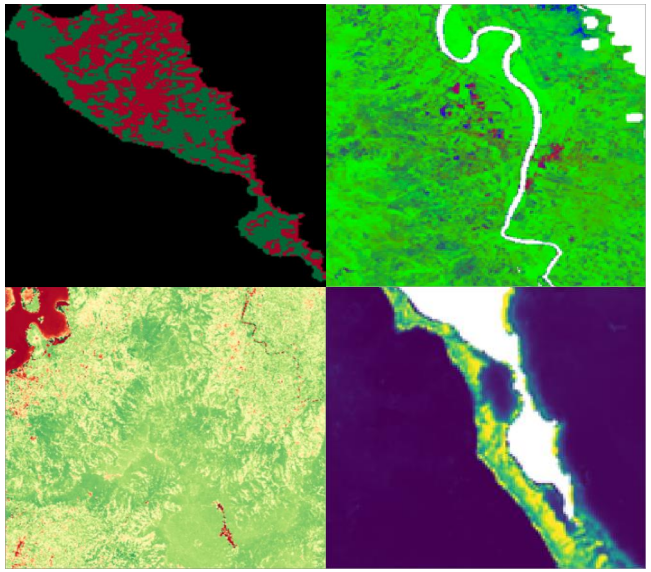






Mangrove Mapping
Completed – 5 Islands





- **Platforms**

ESRI Server and Apps [Government ITC Data Center]

OpenDataCube [USP ITS]

COMMONSENSING SOLUTIONS

DECISION SUPPORT PLATFORM - DISASTER RISK RESILIENCE INFORM INDEX

- National Risk Index System - Visualise risk data at sub-national district *(Tikina)* Level

CLIMATE APPLICATION

- Climate observation (e.g temperature, precipitation)
  - Can include loaded layers of climate projections from PEBACC

Testing Phase

IMAGERY ARCHIVE

- VERY HIGH RESOLUTION SATELLITE IMAGERY

OPENDATACUBE

- CHANGE DETECTION (LANDUSE, LANDCOVER, WATER BODIES, VEGETATION)

Products requested

DOVU GIS and CROP MODEL

- Yield detection and prediction tool
- Crop investment analysis (where to inject more resources along the production chain), overlaid with underlying climate variable and metrics.
- Sugar, Taro, Rice, Cassava, Ginger.

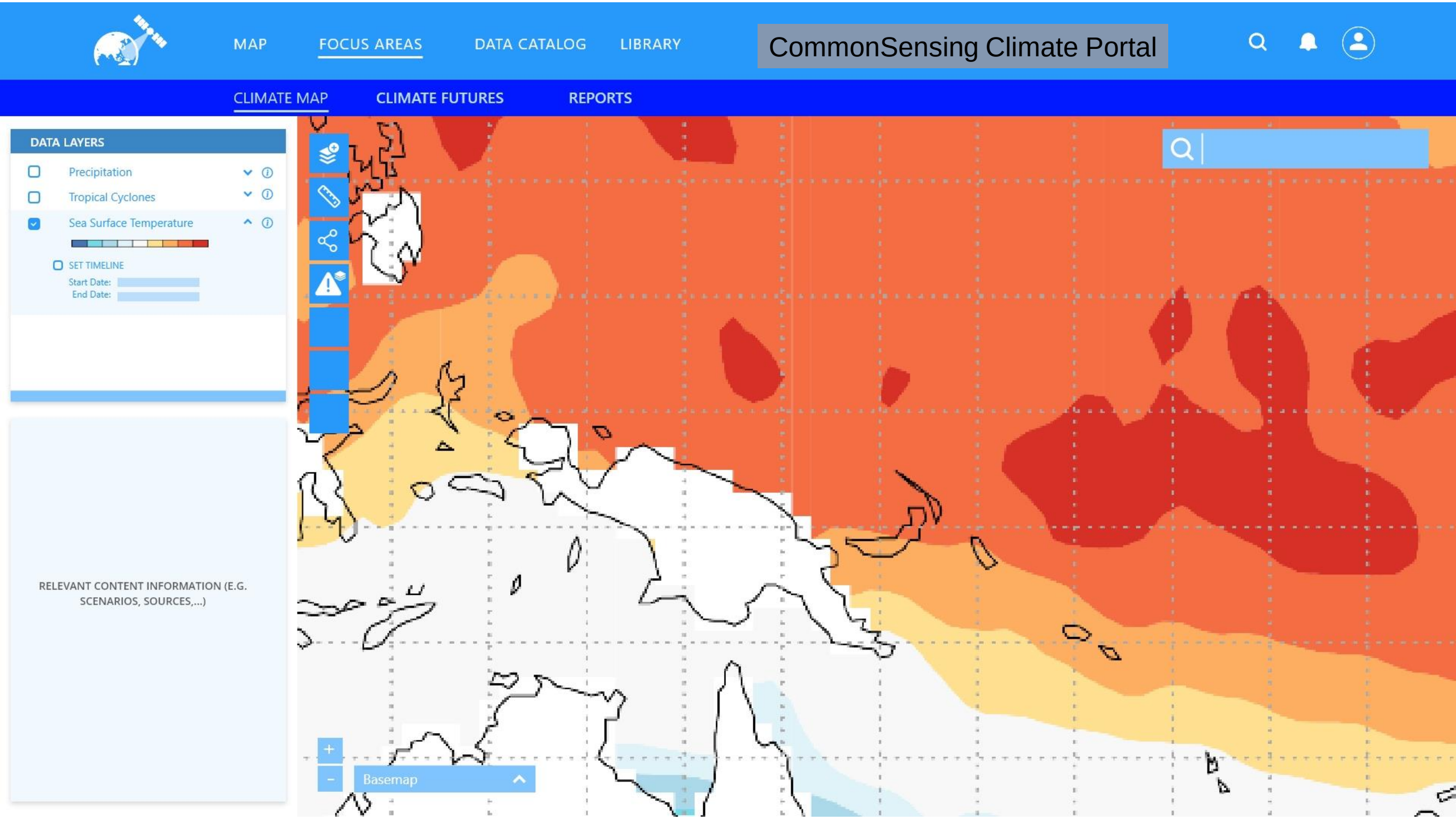
RISK INDEX

- RUN-UP HAZARD MODEL FOR SELECTED SITES AROUND VITI LEVU

COMMONSENSING KNOWLEDGE HUB

- TRAINING MATERIALS AND MODELS
- DATA AND LEARNING MATERIALS

Development in progress


MAP
FOCUS AREAS
DATA CATALOG
LIBRARY
CommonSensing Climate Portal
CLIMATE MAP
CLIMATE FUTURES
REPORTS
DATA LAYERS
Precipitation
Tropical Cyclones
Sea Surface Temperature
SET TIMELINE
Start Date:
End Date:
RELEVANT CONTENT INFORMATION (E.G. SCENARIOS, SOURCES,...)
Basemap

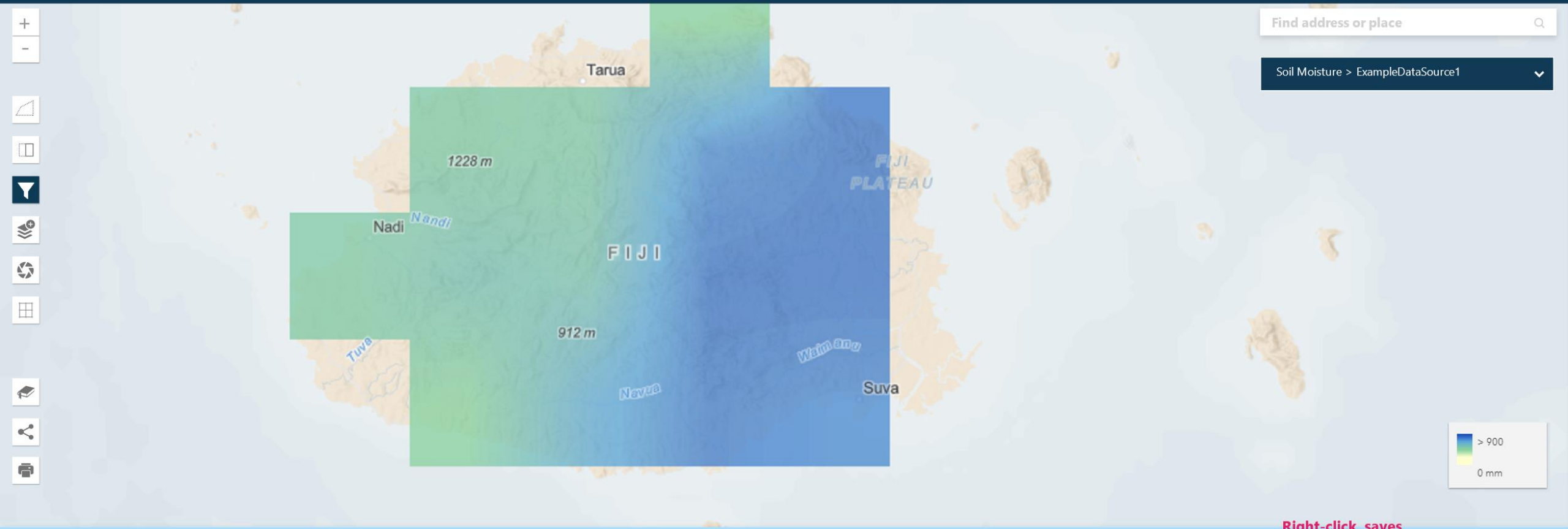
MAP FOCUS AREAS DATA CATALOG LIBRARY

CommonSensing Climate Portal

CLIMATE MAP CLIMATE FUTURES REPORTS

CS Climate Information Application

Pacific Climate Futures Sea Level Rise eLearning



Right-click, saves the graph as a .jpg

Data Source e.g. Cruu

Reporting Period Multiple selection: Annual, Monthly, Daily - select one or more months

Timeframe

Yrs of running avg

ENSO Min Max Average

Download as .csv

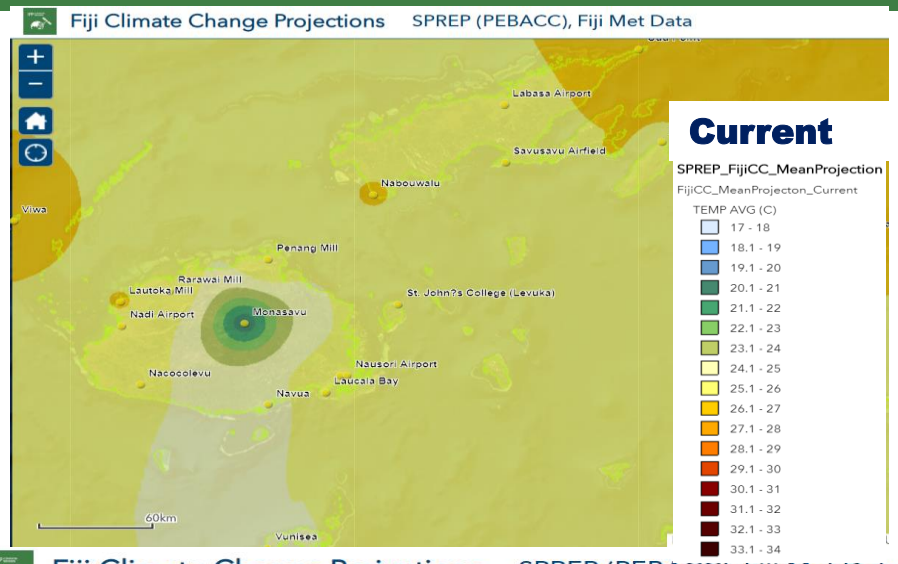
Interpolated datasets

Name	Website	Spatial Resolution	Temporal Availability	Frequency	Variables
CMAP	https://www.cpc.ncep.noaa.gov/products/global_precip/html/wpage.cmap.html	2.5 x 2.5°	1979 onwards	Monthly and pentad	Precipitation
GPCP (monthly)	https://www.esrl.noaa.gov/psd/data/gridded/data.gpcp.html	2.5 x 2.5°	1979 onwards	Monthly (climatology also available)	Precipitation
GPCP (daily)	https://climatedataguide.ucar.edu/climate-data/gpcp-daily-global-precipitation-climatology-project	1 x 1°	1996 onwards	Daily	Precipitation
TRMM	https://pmm.nasa.gov/data-access/downloads/trmm	0.25 x 0.25°	1998 to 2015	3-hourly	Precipitation
CRU TS4.03	https://crudata.uea.ac.uk/cru/data/hrg/	0.5 x 0.5° (land areas only)	1901 to 2018	Monthly	Several inc. precip. and temperature

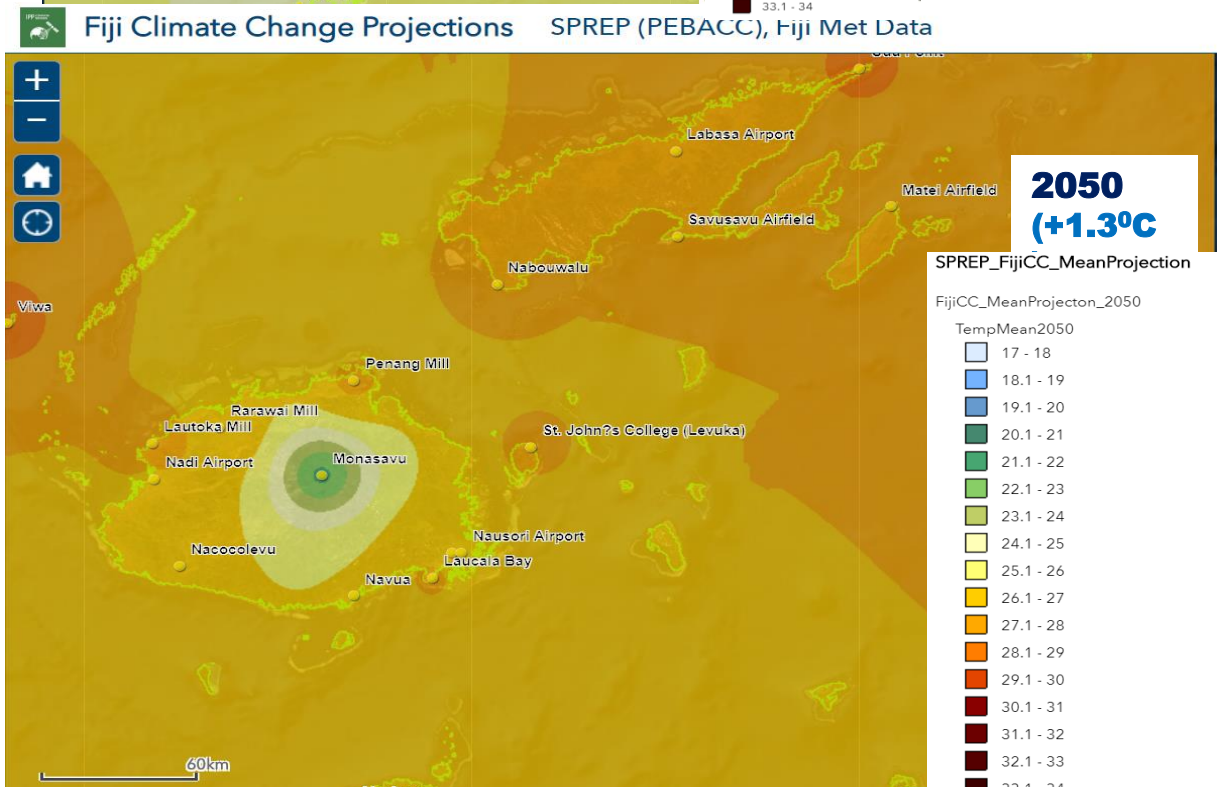
Fiji Climate Change Projections (PEBACC)

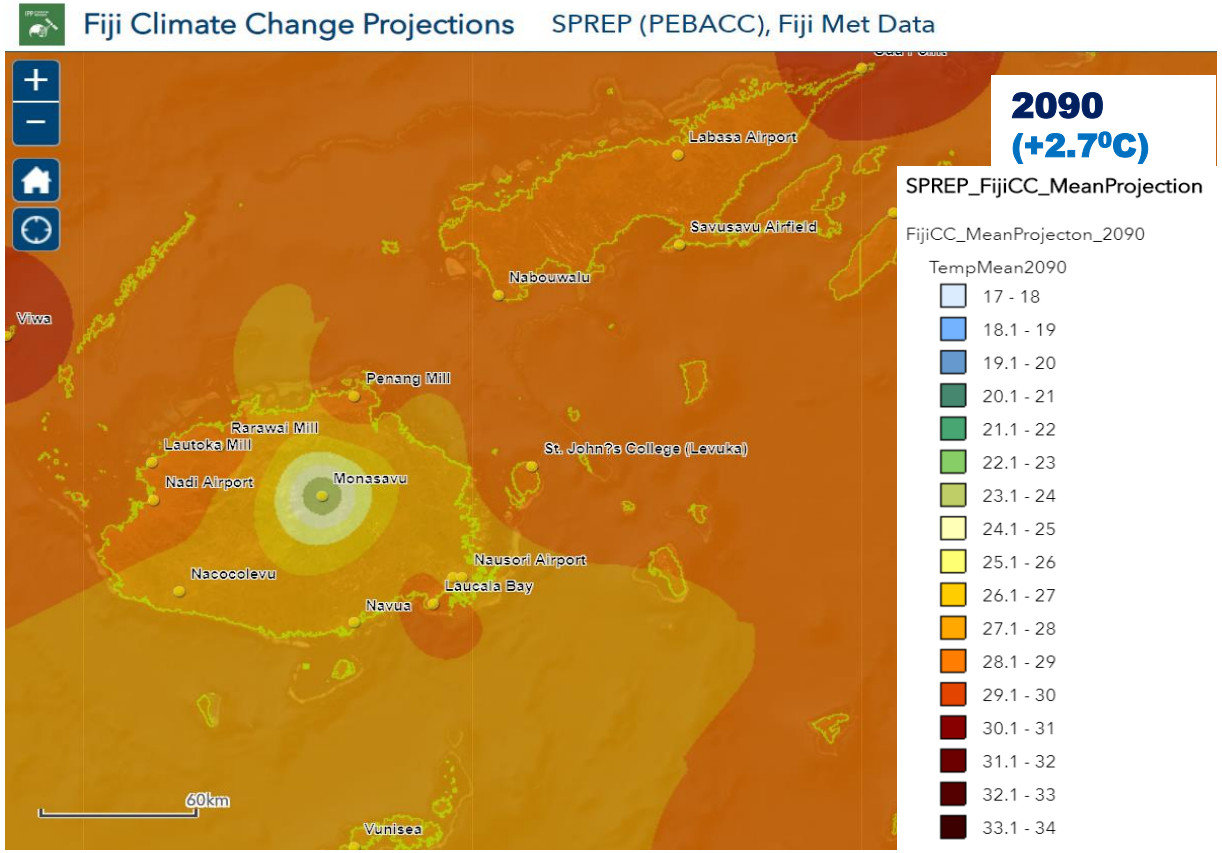
SPREP
Secretariat of the Pacific Regional Environment Programme

Fiji CC Projection - Mean Surface Air Temperature (^{0} Celsius)



Webmap Link





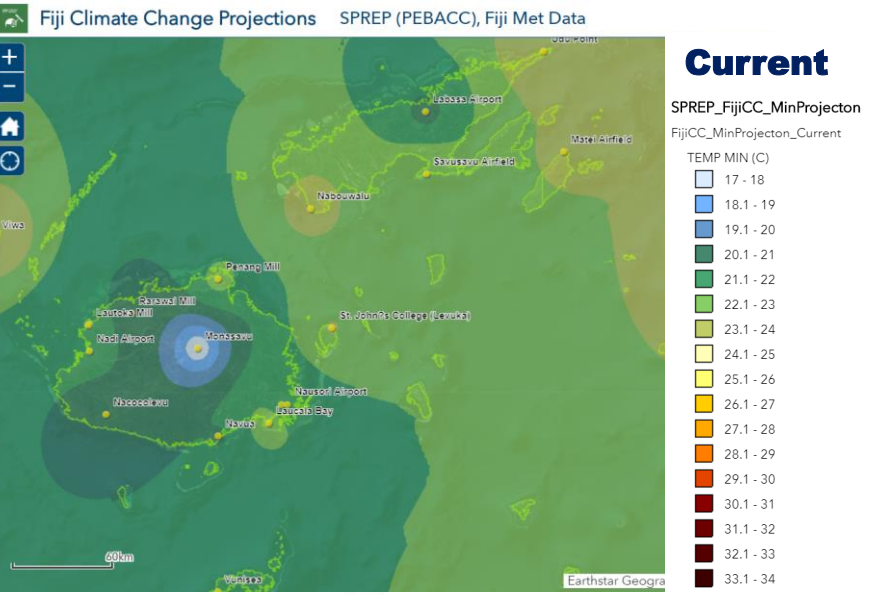
Webmap Link

Fiji Climate Change Projections (PEBACC)

SPREP
Secretariat of the Pacific Regional Environment Programme

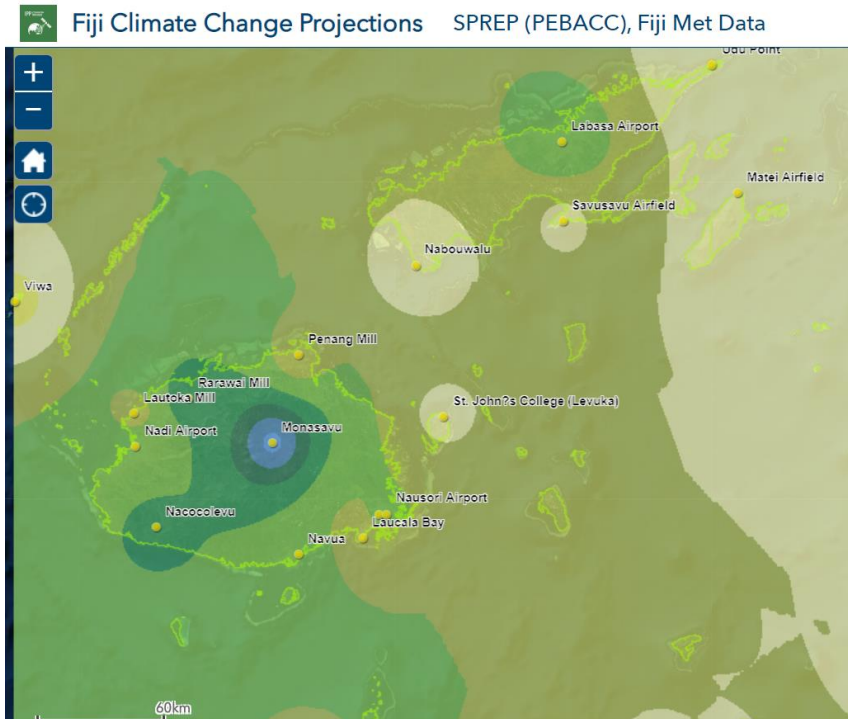
Fiji CC Min Projection, Temperature (^{0} Celsius)

Webmap Link



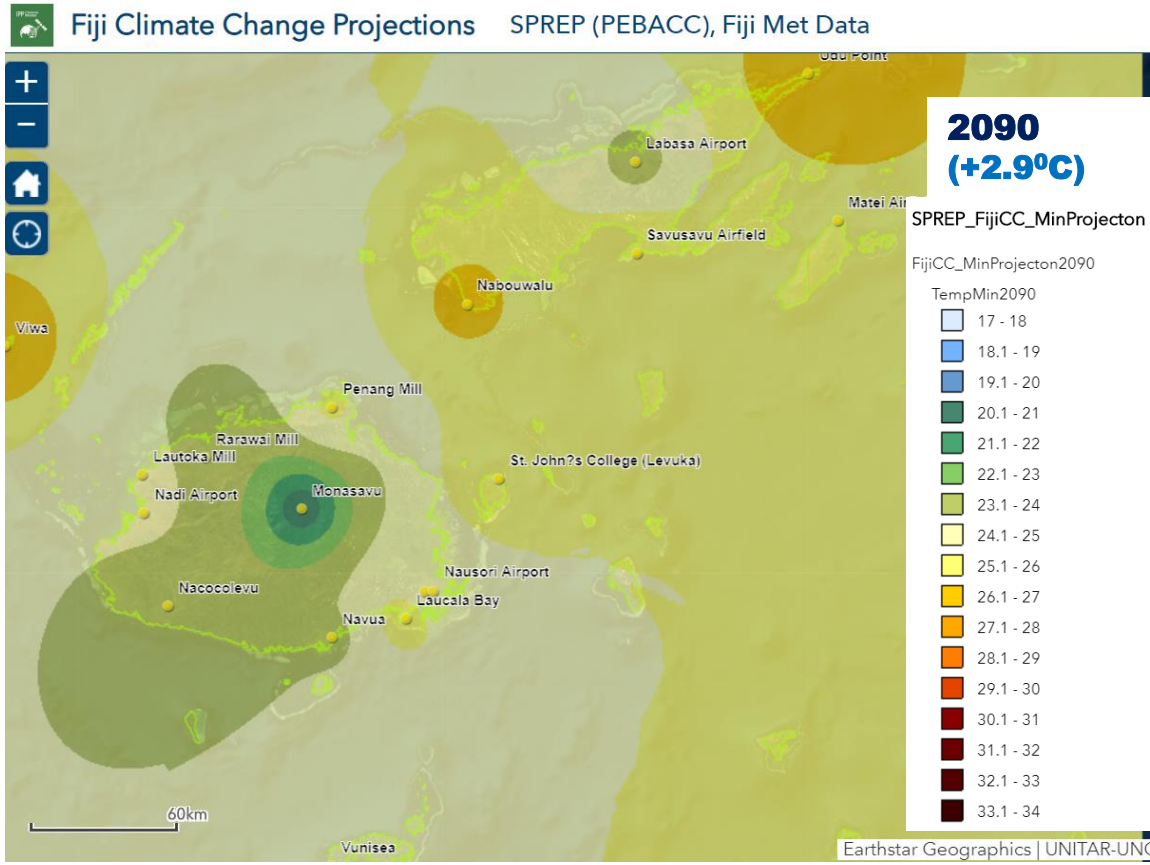
Current

SPREP_FijiCC_MinProjecton
FijiCC_MinProjecton_Current
TEMP MIN (C)
17 - 18
18.1 - 19
19.1 - 20
20.1 - 21
21.1 - 22
22.1 - 23
23.1 - 24
24.1 - 25
25.1 - 26
26.1 - 27
27.1 - 28
28.1 - 29
29.1 - 30
30.1 - 31
31.1 - 32
32.1 - 33
33.1 - 34



2050 (+1.3^{0}C)

SPREP_FijiCC_MinProjecton
FijiCC_MinProjecton_2050
TempMin2050
17 - 18
18.1 - 19
19.1 - 20
20.1 - 21
21.1 - 22
22.1 - 23
23.1 - 24
24.1 - 25
25.1 - 26
26.1 - 27
27.1 - 28
28.1 - 29
29.1 - 30
30.1 - 31
31.1 - 32
32.1 - 33
33.1 - 34



2090 (+2.9^{0}C)

SPREP_FijiCC_MinProjecton
FijiCC_MinProjecton2090
TempMin2090
17 - 18
18.1 - 19
19.1 - 20
20.1 - 21
21.1 - 22
22.1 - 23
23.1 - 24
24.1 - 25
25.1 - 26
26.1 - 27
27.1 - 28
28.1 - 29
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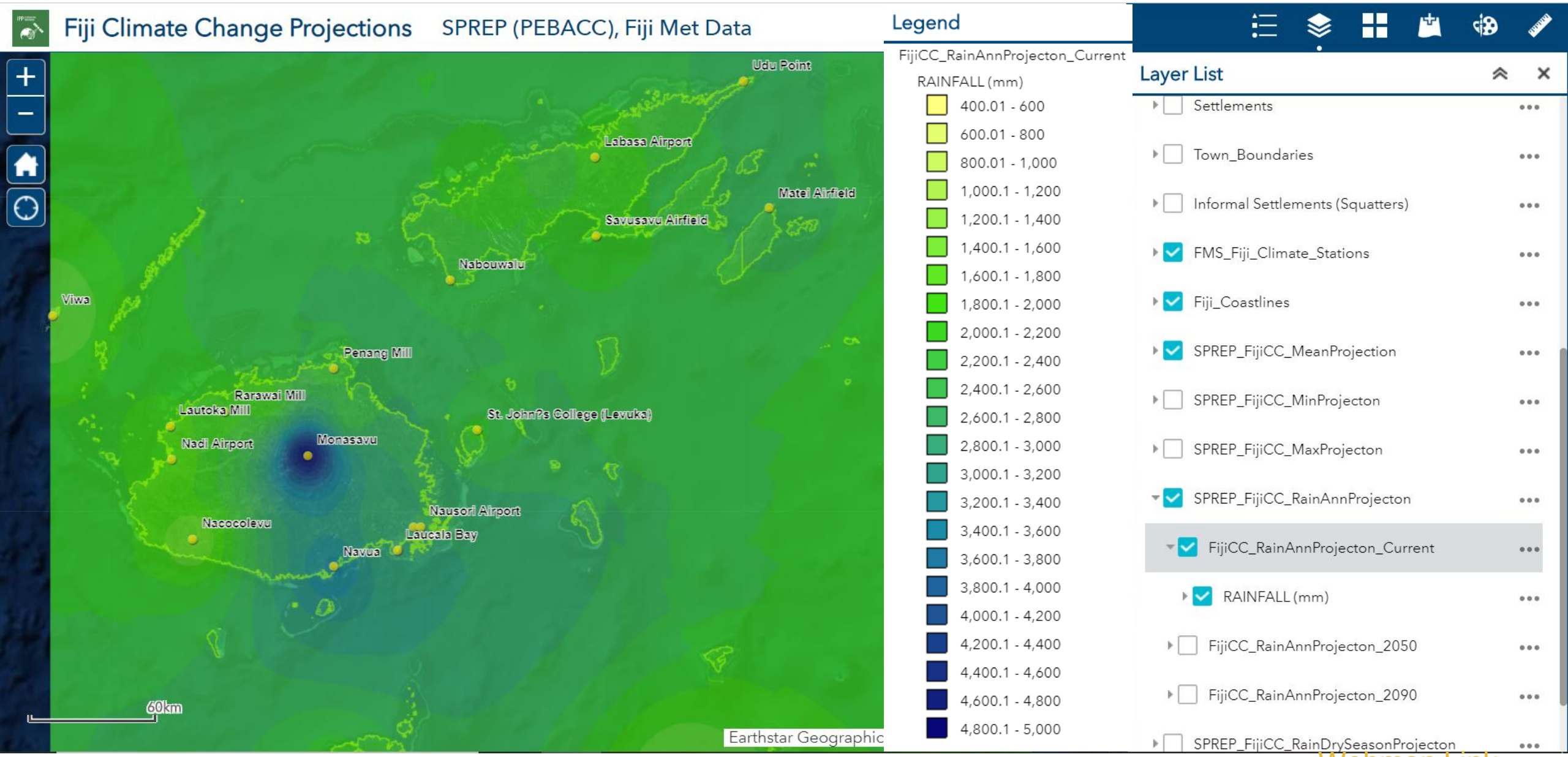
31.1 - 32
32.1 - 33
33.1 - 34

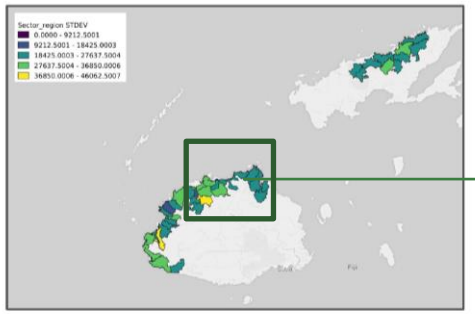
Fiji Climate Change Annual Rainfall Current



Webmap Link

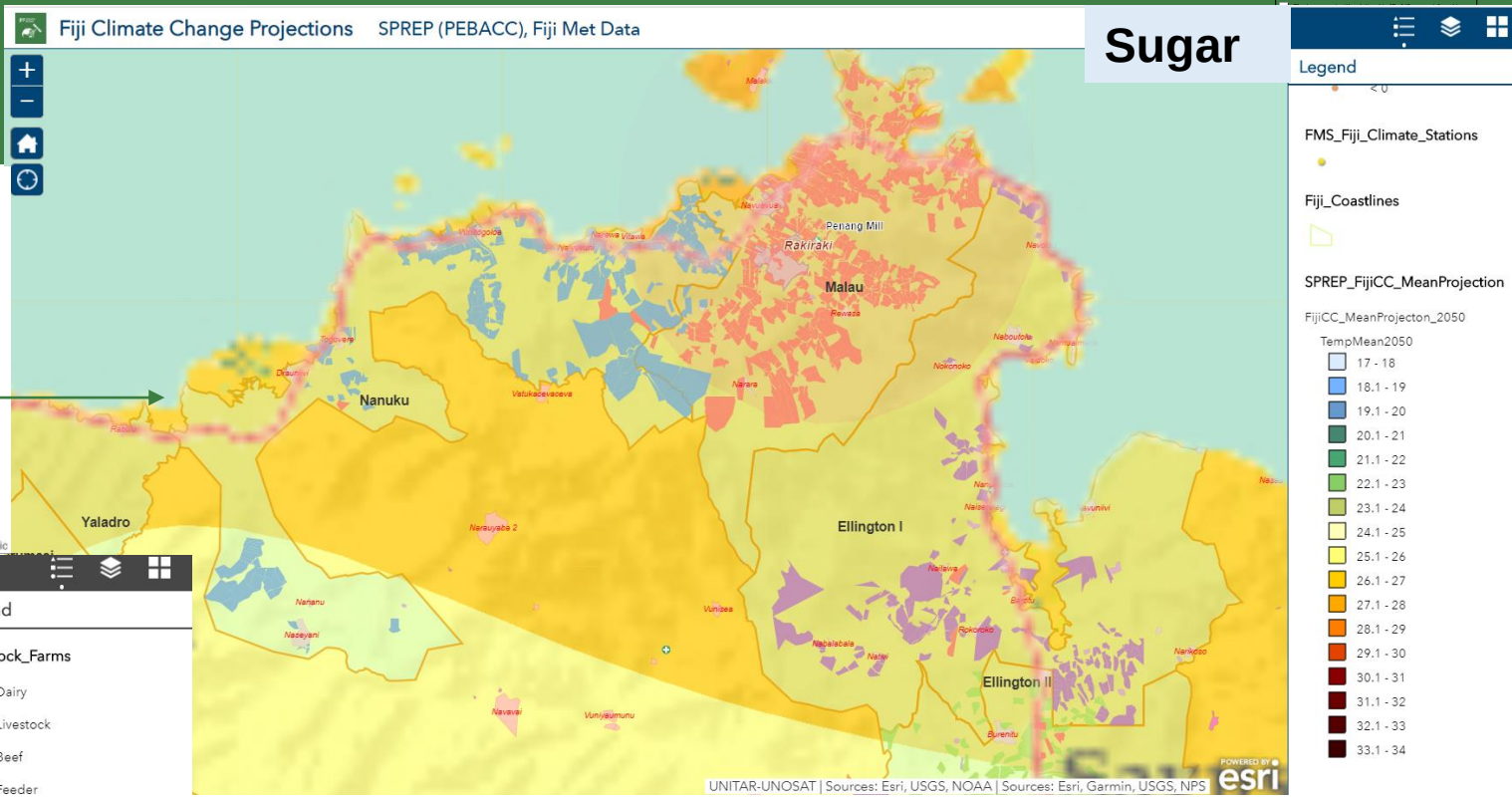
Sector Impacts – Agriculture

Some sectors have greater year-to-year variation in cane production levels

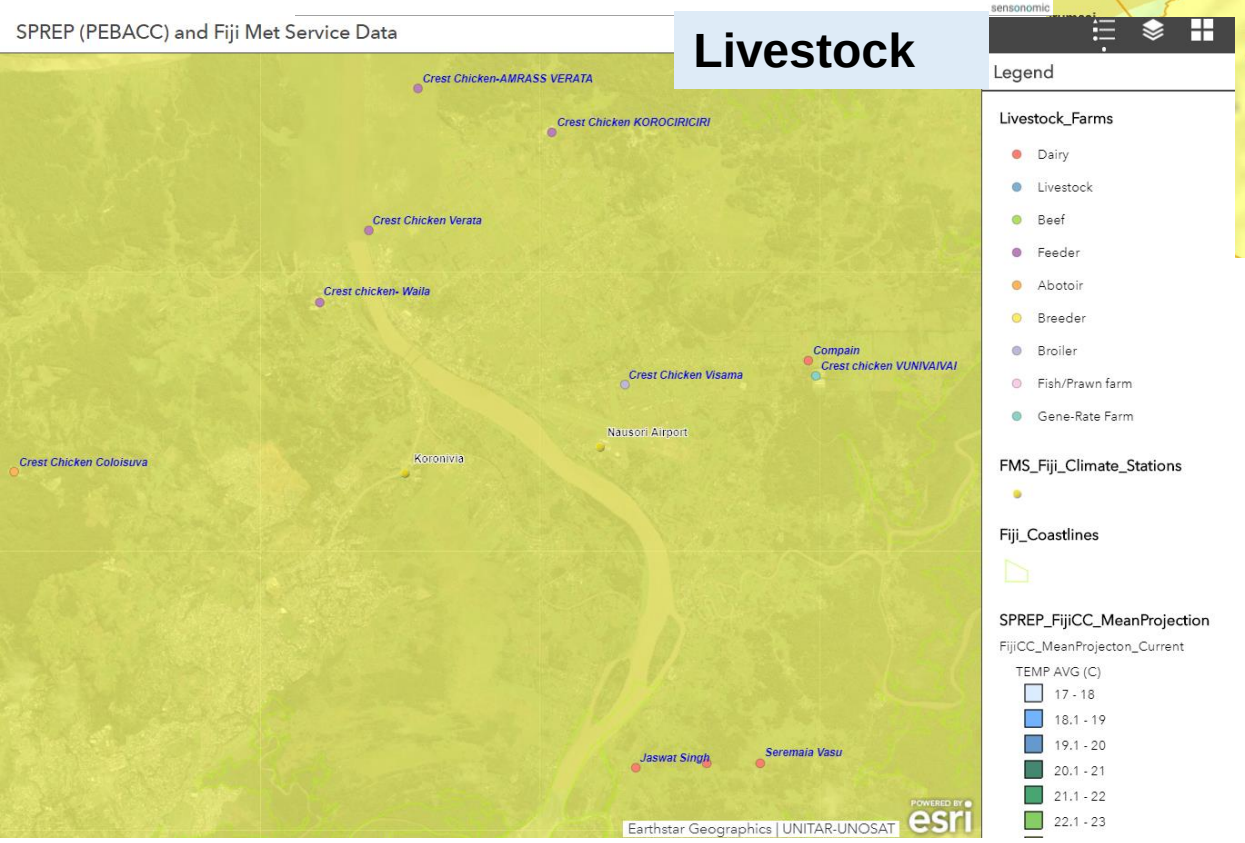


Map showing standard deviation of cane production years 2000 - 2018 by sector

Sugar



Livestock



Climate projections overlaid with sugar production figures to see potential impact of climate on sugar yield.

Rising temperatures attribute changes to natural resources that can threaten farmers ability to sustainably produce and maintain quality crops/commodities

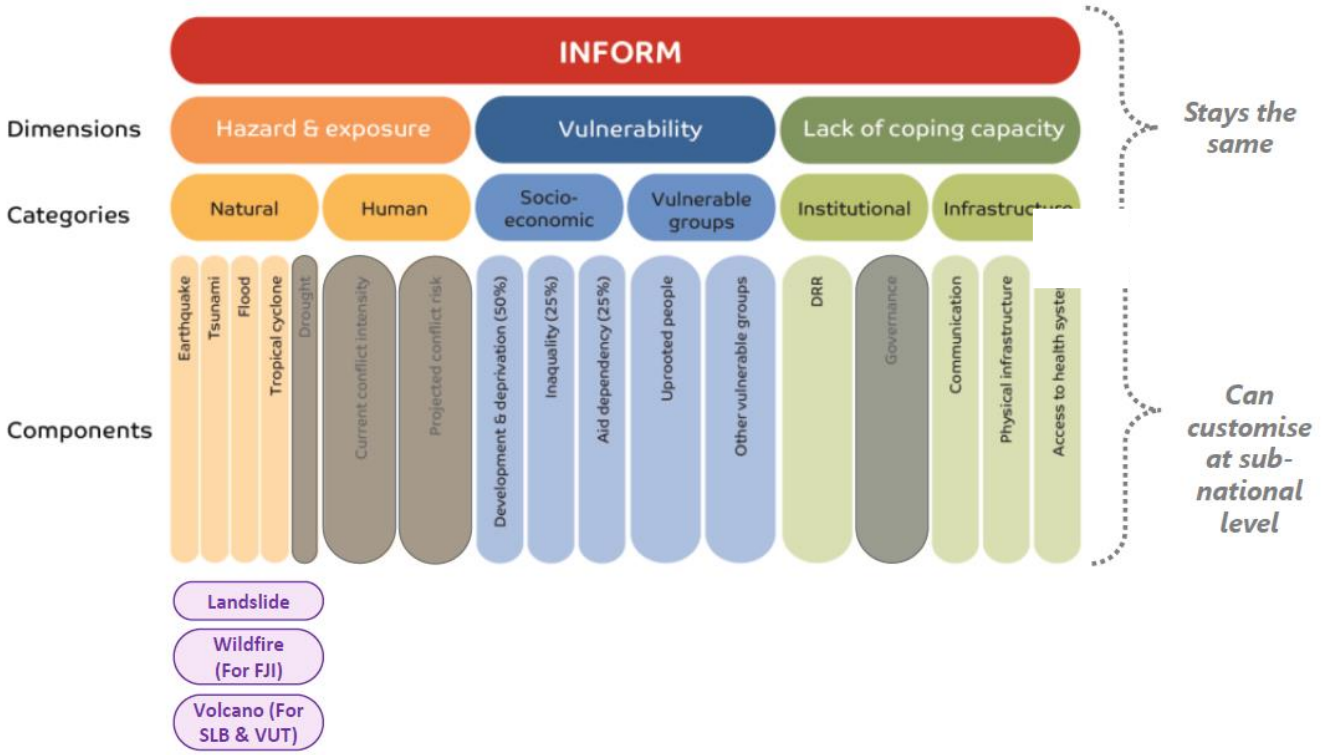
INFORM RISK INDEX

Fiji – Sub-national (district) level

INFORM, a global open source risk assessment for humanitarian crisis and disasters.

Intended to support disaster prevention, preparedness and response

Suggested structure for sub-national INFORM



CommonSensing

Decision Support Analytics

Supporting decision-makers in answering the critical questions related to climate change resilience

Descriptive

The descriptive analytics will present the INFORM risk index at the sub-national level, where users can easily recognise the relative risks of different administrative unit

LAUNCH TOOL

Diagnostic

The diagnostic analytics breaks down the INFORM risk index into exposure to hazard, vulnerability, and lack of coping capacity indexes for selected sub-national levels

LAUNCH TOOL

MCDA

The Multiple Criteria Decision Analysis tool intends to empower decision-makers with objective evaluations on different Disaster Risk Reduction options.

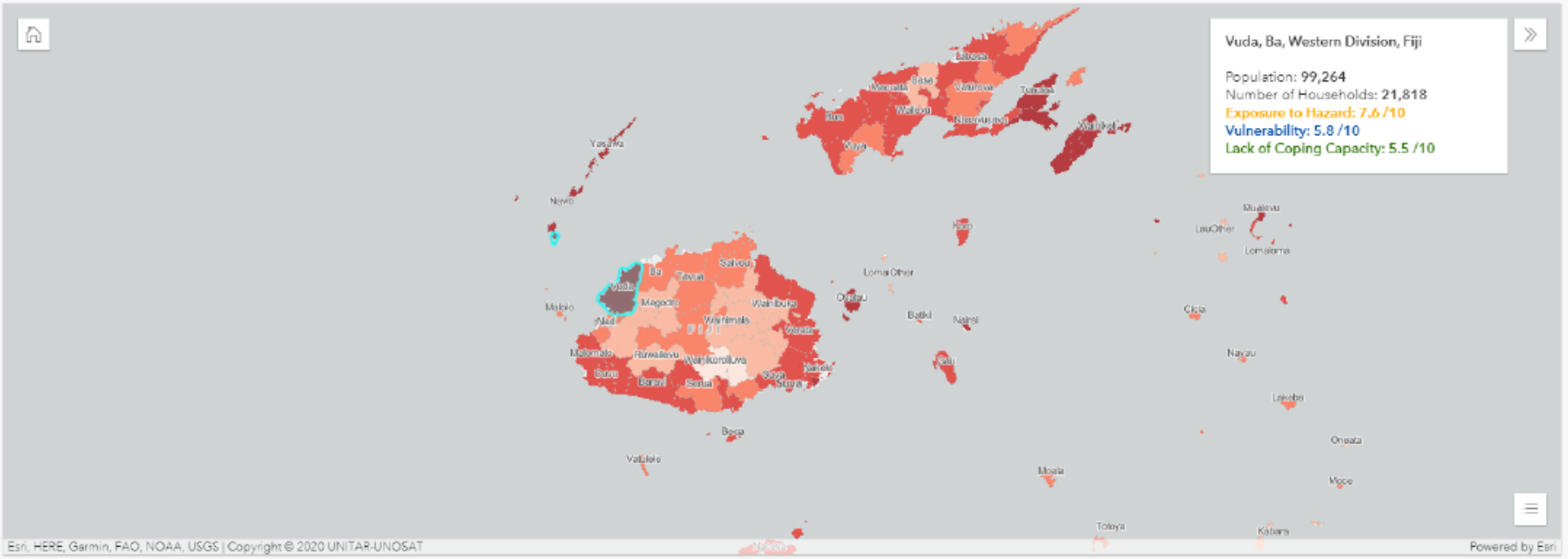
LAUNCH TOOL

Decision Support System
for Enhanced Disaster Risk Reduction

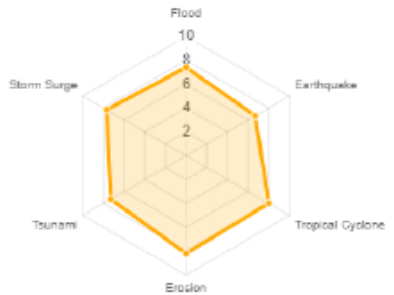
Descriptive | Diagnostic | Multiple Criteria Decision Analysis | Data Quality Assessment

Where is the highest overall risk?

- 6.9 - Nairai (0.5k ppl)
- 6.8 - Naviti (2.9k ppl)
- 6.7 - Yasawa (2.2k ppl)
- 6.6 - Ovalau (9.6k ppl)
- 6.5 - Cakaudrove (14.6k ppl)
- 6.4 - Tunuloa (3.8k ppl)
- 6.3 - Wainikeli (4.5k ppl)
- 6.2 - Mualevu (0.8k ppl)
- 6.2 - Vuda (99.3k ppl)
- 6.2 - Noco (3.7k ppl)
- 6.1 - Nakorotubu (4.4k ppl)
- 6.1 - Bua (6.2k ppl)
- 6.1 - Serua (16.4k ppl)
- 6.1 - Saqani (2k ppl)
- 6.1 - Koro (2.9k ppl)
- 6 - Nakasaleka (2.5k ppl)
- 6 - Bau (31k ppl)
- 6 - Suva (94.1k ppl)
- 5.9 - Nakelo (10.9k ppl)
- 5.9 - Sawakasa (8.6k ppl)
- 5.9 - Lomaloma (0.9k ppl)
- 5.9 - Gau (2.2k ppl)
- 5.9 - Cikobia (0.1k ppl)
- 5.9 - Macuata (9.4k ppl)
- 5.9 - Naitasiri (160k ppl)
- 5.8 - Batiki (0.2k ppl)
- 5.8 - Nabukelevu (2.6k ppl)
- 5.8 - Naceva (1.8k ppl)

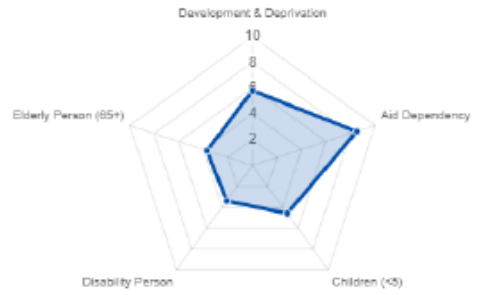


EXPOSURE TO HAZARD: 7.6



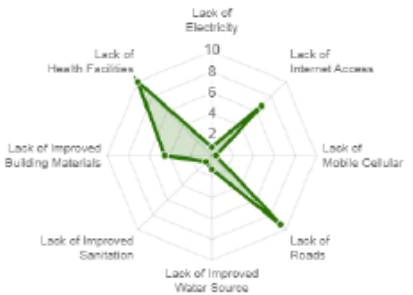
Events that could occur and the people or assets potentially affected.

VULNERABILITY: 5.8



The susceptibility of communities to those hazards.

LACK OF COPING CAPACITY: 5.5



Lack of resources available that can help absorb the shock.

Catapult Open

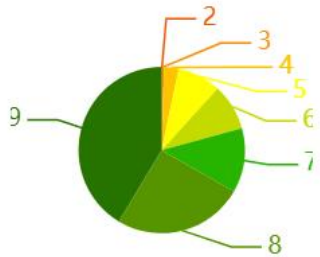
Decision Support System for Enhanced Disaster Risk Reduction

Descriptive | Diagnostic | Multiple Criteria Decision Analysis | Data Quality Assessment

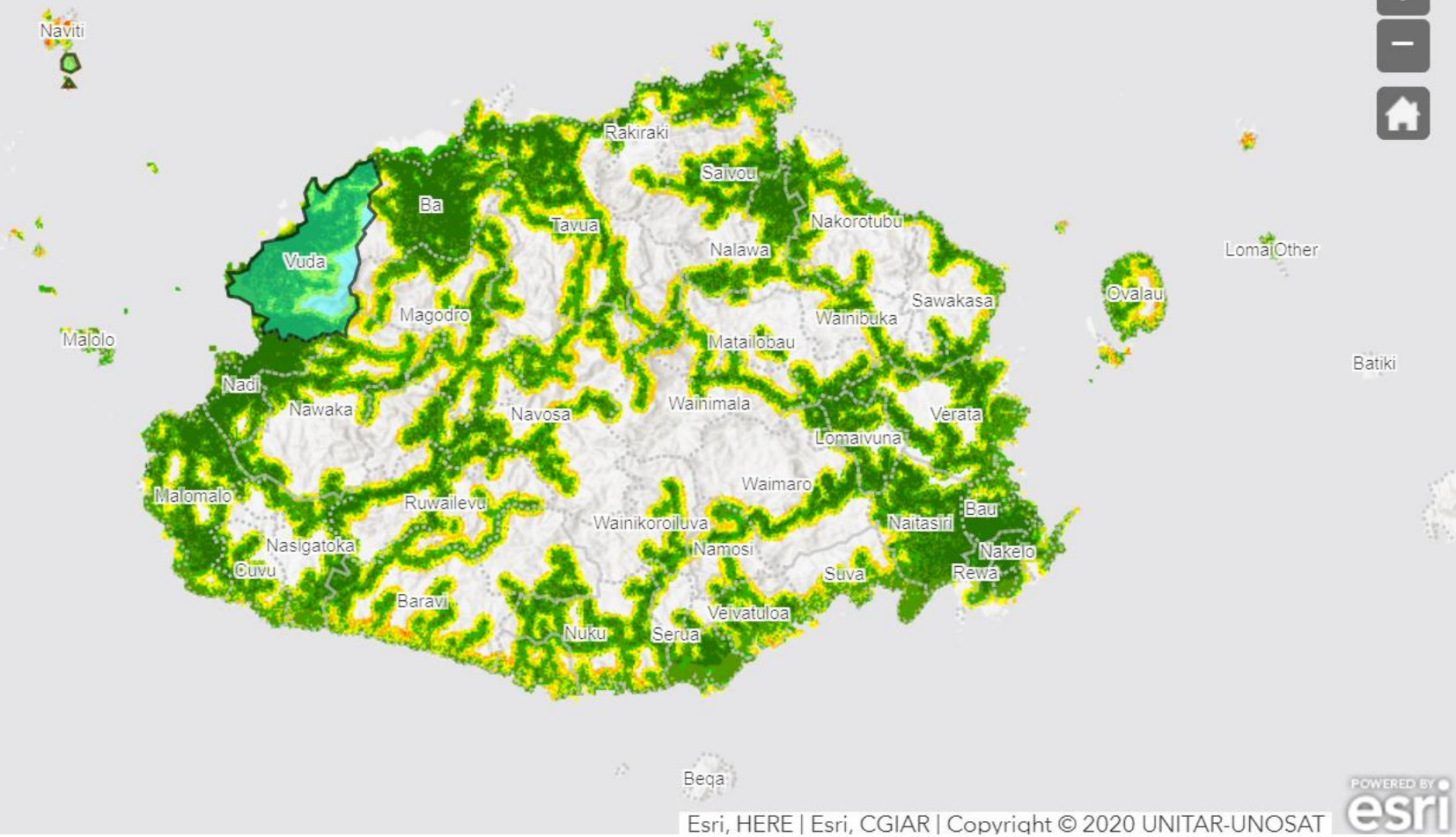
Layers | Model | Chart

Features Clear

Fiji: Administrative (Tikinas)



2 - Very Low	0.14%
3 - Low	0.30%
4 - Low Medium	2.86%
5 - Medium	8.45%
6 - High Medium	9.02%
7 - High	12.53%
8 - Very High	25.35%
9 - Extremely High	41.36%

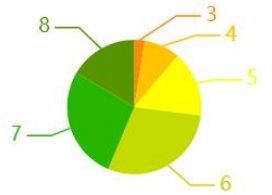


Decision Support System
for Enhanced Disaster Risk Reduction

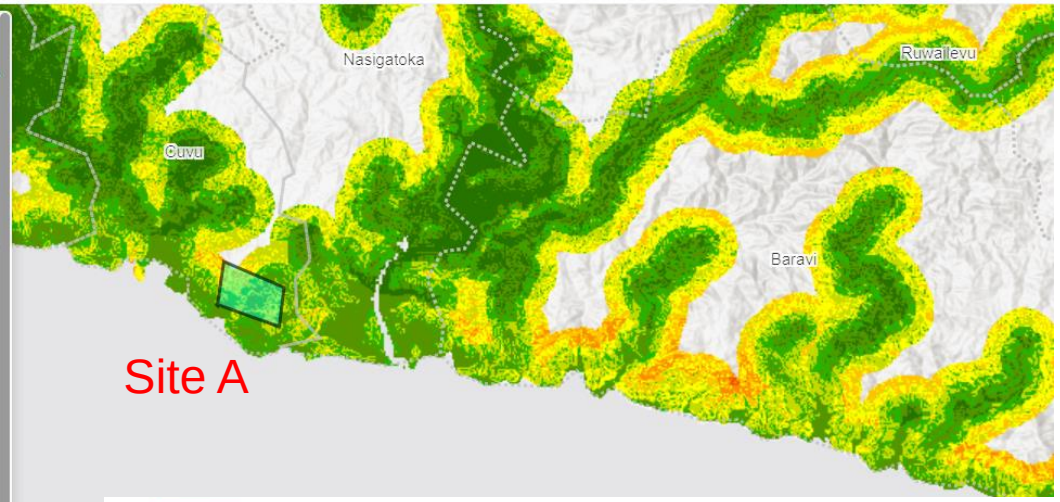
Descriptive | Diagnostic | Multiple Criteria Decision Analysis | Data

Layers | Model | Chart

Features Clear



3 - Low	2.53%
4 - Low Medium	8.71%
5 - Medium	15.75%
6 - High Medium	29.36%
7 - High	27.17%
8 - Very High	16.47%



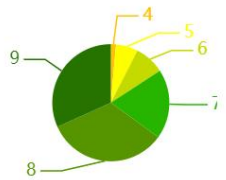
Site A

Decision Support System
for Enhanced Disaster Risk Reduction

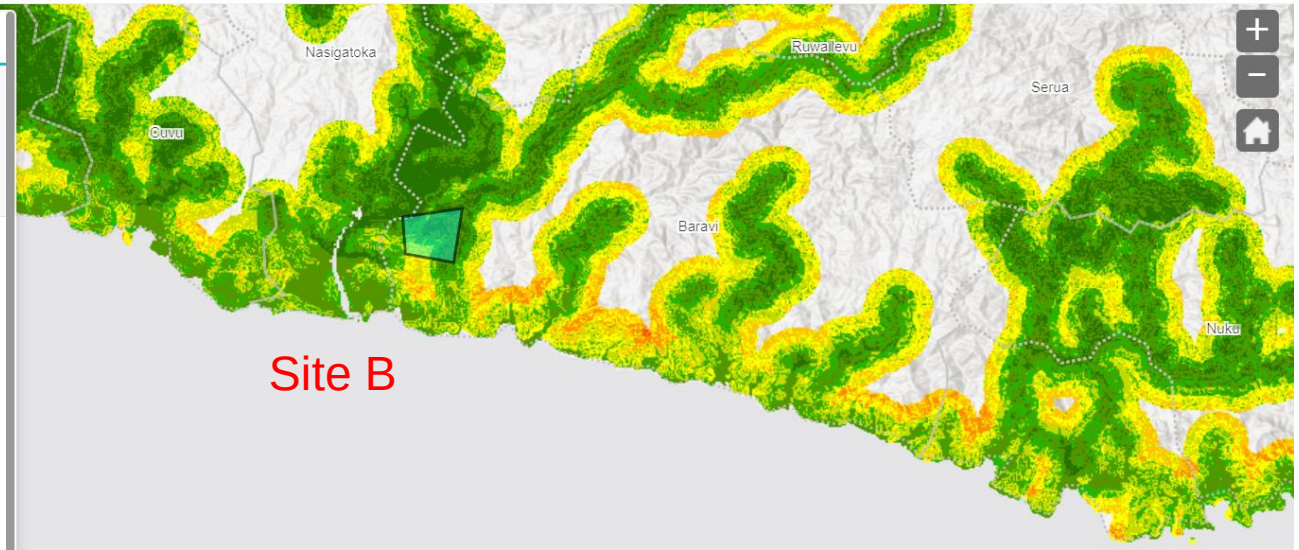
Descriptive | Diagnostic | Multiple Criteria Decision Analysis | Data Quality Assessment

Layers | Model | Chart

Features Clear

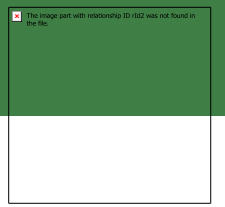


4 - Low Medium	1.41%
5 - Medium	6.10%
6 - High Medium	8.30%
7 - High	19.17%
8 - Very High	33.29%
9 - Extremely High	31.74%



Site B

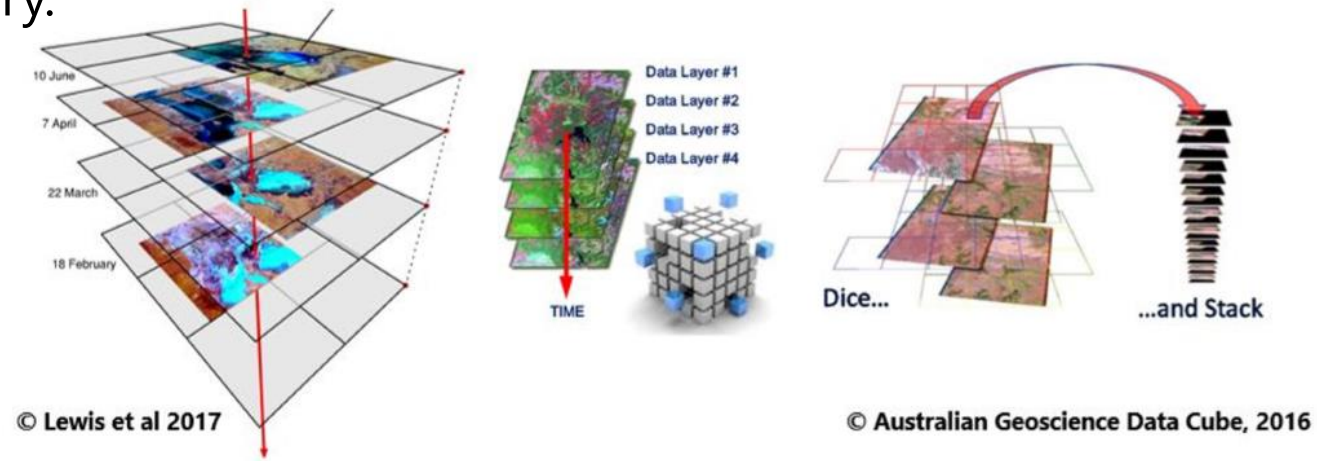
Esri, HERE | Esri, NASA, NGA, USGS | Copyright © 2020 UNITAR-UNOSAT



The OpenDataCube

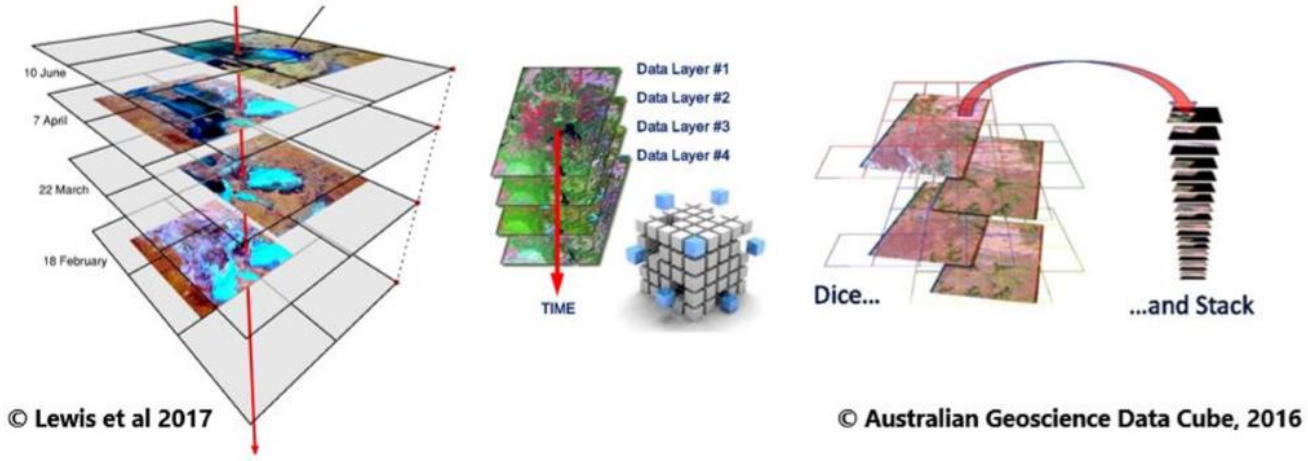
The Data Cube

- CommonSensing is using the open source Open Data Cube (ODC) technology developed by Geoscience Australia as our solution for the storage of satellite Analysis Ready Data (ARD) and derived products.
- A Data Cube for EO data, is the concept of creating a multi-dimensional array database to store standardised raster data and metadata.
- Once ARD raster data is ready and stored within the Data Cube, algorithms can then be run on the Cube to query it spatially or temporally (or both) to create data products from the ARD source imagery.



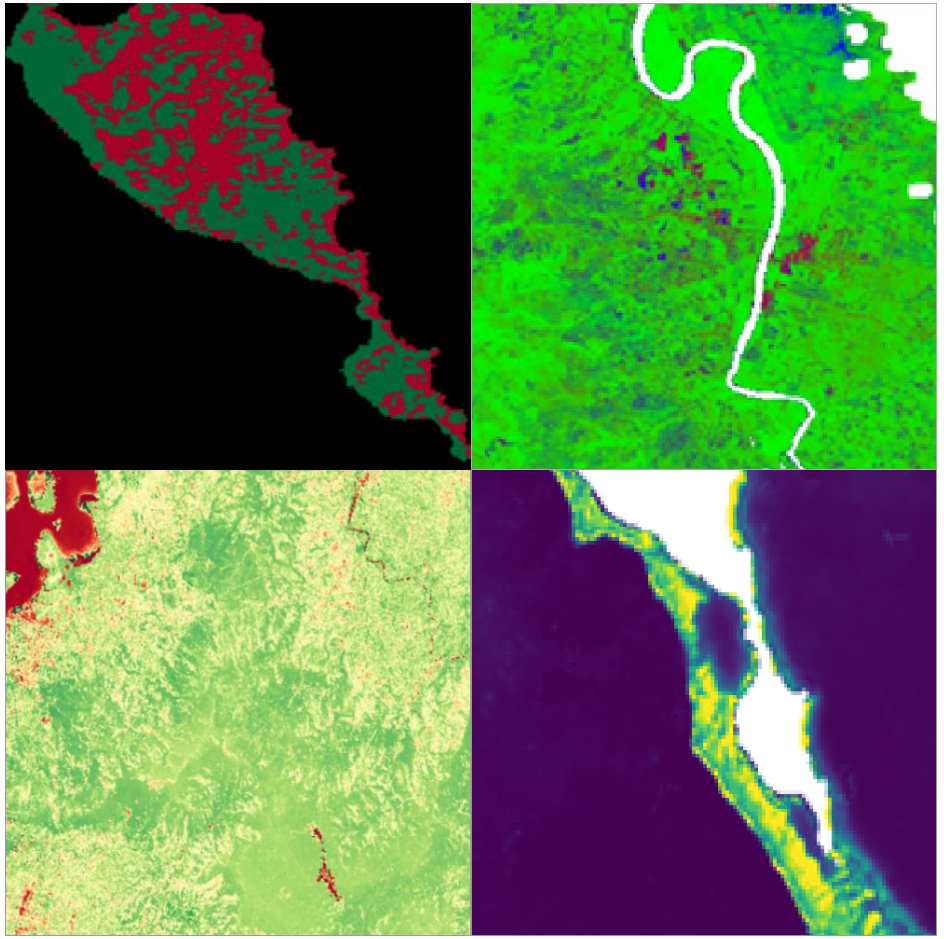
Technologies needed

- At its core, the Data Cube is simply a set of Python libraries and a PostgreSQL database now engineered for it to scale to operate at national level
- To do this, a number of technologies are used including DASK, Xarray, Docker, Kubernetes, S3-type Buckets



CommonSensing and the Data Cube

- Deployed a number of Cube environments for development, testing and production.
- Loaded Sentinel-1, Sentinel-2 and Landsat ARD data into the Cube for all 3 Pacific islands nations (Fiji, Vanuatu and Solomon Islands).
- Developed a Data Cube API to allow users to access and use the Cube from within their GIS App.
- Developed a number of Data Cube products.



Data Cube Products Overview

ARD

- Sentinel-2 ARD
- Landsat ARD
- Sentinel-1 ARD
- Water Masks

Routine

Routine products are pre-generated at set time intervals, designed to save time and compute on commonly used products.

- Geomedian
- Shoreline Extraction
- Water Permanency
- Fractional Cover

On-Demand

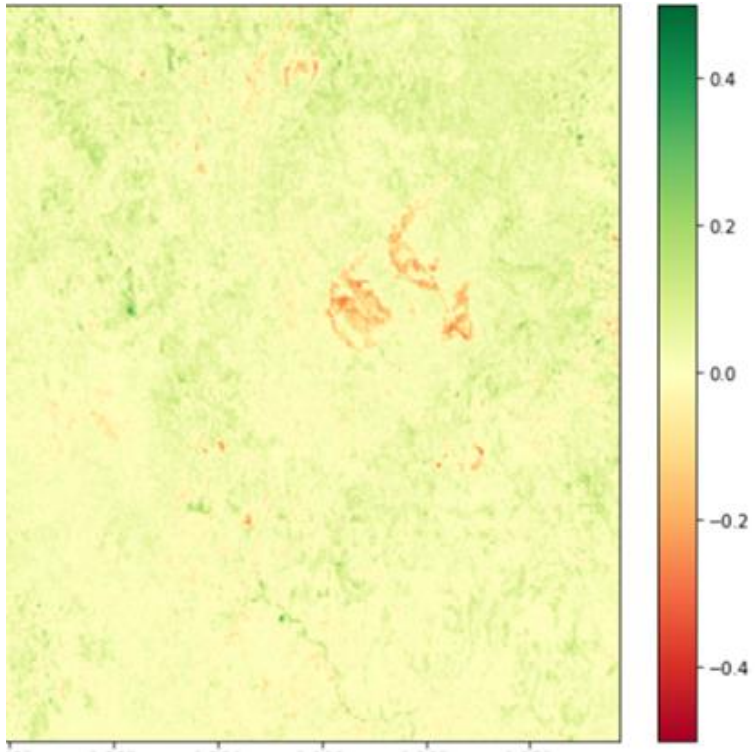
These products are generated based on user-defined inputs such as time periods, and area.

All Routine Products +

- Water Change
- Aggregate Indices
- NDVI Anomaly
- Vegetation Change
- Land Degradation
- Water Quality

NDVI Anomaly

On-Demand



Value Range: -1 to 1

Sensors:

- Sentinel-2
- Landsat series

Query Parameters:

Baseline Time Range	Baseline Sensor	Resolution	Coordinate Reference System
Analysis Time Range	Analysis Sensor	Area of Interest	Mosaic Type

Description:

The Normalised Difference Vegetation Index (NDVI) represents the chlorophyll content of a surface – the 'greenness'. This product represents the change of NDVI between two user-defined time periods. Areas of positive change represent an increase in vegetation on the surface, whilst negative values represent a decrease.

Use Cases:

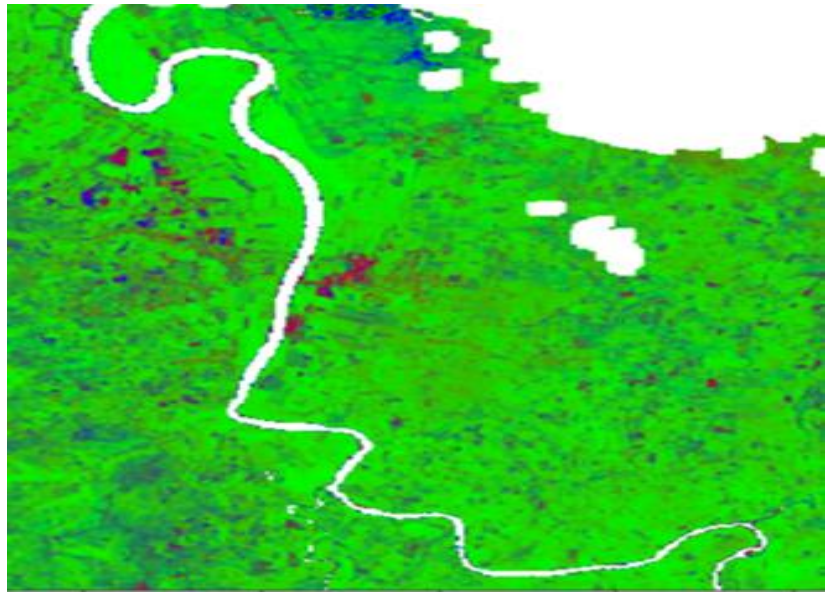
Analyse long-term or abrupt land use changes, natural seasonal variances may exist, so need to be cautious when choosing date ranges that you are experiencing actual change not seasonal.

Cube Process:

- Query Data cube
- Check for products
- Load products
- Mask Clouds
- Mosaic
- Mask Water
- Calculate NDVI (NIR-RED)/(NIR+RED)
- Anomaly calculation (Analysis – Baseline)
- Product

Fractional Cover

On-Demand | Routine: Annual Product



Value Range: Each of the 3 bands 0 to 100

Sensors:

- Sentinel-2
- Landsat series

Query Parameters:

- Time Range
- Sensor
- Coordinate Reference System
- Area of Interest
- Resolution

Description:

Fractional Cover is a land cover product based upon three fractions:

- Bare Soil (Red)
- Photosynthetic vegetation (Green)
- Non-photosynthetic Vegetation (Blue)

The fractions are represented as an RGB image, where the color represents the dominance of each fraction within a pixel.

Use cases:

This land cover product can be used to look at static land cover which could be useful for planning and impact assessment.

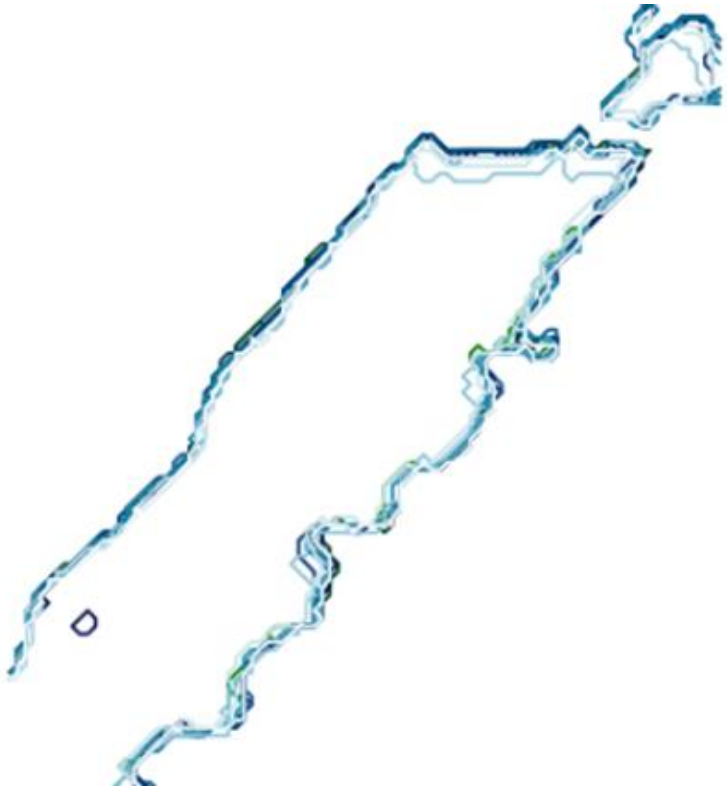
Cube Process:

1. Query Data cube
2. Check for products
3. Load products
4. Mask Clouds
5. Mosaic by Geomedian
6. Mask Water
7. Calculate Fractional Cover
8. Product

Shoreline Extraction

On-Demand

Routine: Annual Product



Value Range: Year.

Sensors:

- Sentinel-2
- Landsat series

Query Parameters:

- Time Range (years)
- Sensors/ Product
- Resolution
- Coordinate Reference System
- Water Threshold
- Tidal Range
- Area of Interest

Description:

The shoreline is derived from detecting the waterline in each image captured over the year, then determining the average shoreline position. This product can be filtered to only use images for a certain tidal range based on tide timetables, as well as number of vectors.

Use Cases:

The annual shoreline location can be used to inform on changing long-term trends in coastline. This may be due to areas of high erosion, deposition or/and rising sea levels. This product could be used to aid decision making on construction of infrastructure such as sea walls or identification of vulnerable communities.

Cube Process:

- Query Data cube
- Check for products
- Load Products
- Filter by Tidal Range
- Mosaic Mean by year
- Extract Shoreline
- Product

Turning the Tide Series Videos & Blogs

Technology is helping SIDS gather data to inform decision making, protect infrastructure, and pursue the funding needed to build economic resilience.

Website:
www.commonsensing.org.gridhosted.co.uk
www.commonsensing.gov.fj (link to be activated)

Outreach events for awareness raising

CONCLUSIONS

Good datasets are required to better support hazard modelling and risk assessments.

Strengthening partnerships, collaboration, communication and inclusion to support resilience and sustainable development.